

LIQUID CRYSTAL DISPLAY DEVICE HAVING THIN GLASS  
SUBSTRATE ON WHICH PROTECTIVE LAYER FORMED AND METHOD  
OF MAKING THE SAME

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BACKGROUND OF THE INVENTION

10 The present invention relates to a liquid  
crystal display device, and more particularly to a  
liquid crystal display device having glass substrates  
uniformly and smoothly formed on its outer surface to  
increase the mechanical strength thereof and method of  
making the same.

15 As a display device of a television and a  
personal computer, etc., a large size cathode ray  
tube(CRT) display device has been used. However, since  
the screen must be separated from the electron gun more  
than predetermined distance for large size screen CRT,  
the volume is increased. Thus, this CRT cannot be  
applied to the thin weight, small size, and low power  
consumption electronic device such as a wall-mounted  
20 television, a portable television and a notebook  
computer, etc.

25 According to the purpose of display device, the  
flat panel display devices such as LCD(liquid crystal  
display), PDP(plasma display panel),

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ELD(electroluminescent display), and VFD(vacuum  
fluorescent display) have been introduced recently.  
Among above flat panel display device, the LCD has been  
dominantly researched for the good picture quality and  
low power consumption. The LCD-applied portable  
television and notebook computer are on the market  
resent, but there are also problems to be solved in  
this LCD yet. Particularly, the size and weight are  
important factor of the LCD investigation because of  
the apparatus have to be in hands of user.

For small size and light LCD, there are several  
methods of reducing the size and weight of the LCD  
element. However, the driving circuit and the thin  
film transistor, which are necessary element of the  
LCD, are so thin that the weight cannot be reduced. On  
the other hand, it is possible to reduce the weight of  
the glass substrate which is a basic element of the  
LCD. Specially, since the glass substrate is most heavy  
element of the LCD, the method of reducing the weight  
of the glass substrate has been continuously  
researched.

The light glass substrate means thin glass  
substrate. However, the thin glass substrate causes  
the damage and the surface roughness, so that the  
mechanical strength is weakened and the image quality

of LCD is deteriorated.

In several etching methods of reducing the thickness of the glass substrate, it is representative that the substrate is etched in a case which was filled with etchant. In this etching method, however, because of impurities created in etching process, the substrate is not uniformly etched.

Therefore in proposed another etching method, the substrate is etched removing the impurities created in etching process by bubbles through a porous plate after a substrate is arranged.

In this method, however, bubbles appear on the substrate, or cracks occur by mechanical impulse, the bubbles were created in process of manufacturing glass and diameters of several  $\mu\text{m}$  - several ten  $\mu\text{m}$ . In case that the substrate applied to a LCD desirable image quality can not be achieved because of scattering of the light in a bubble region. Further if the cracks occur on the substrate by an etching process of the glass or mechanical impulse, impurities pass into the substrate in manufacturing process of the LCD thereby a quality of the LCD is down. In addition, since the crack is intensified according to passing of time, thereby the substrate is brokendown.

Accordingly in order to decrease weight of the

LCD by etching the substrate, it is very important to decrease a fault on the substrate as well as an etching method.

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#### SUMMARY OF THE INVENTION

10 An object of the present invention is to provide the LCD having thin glass substrate which is light and its surface is smooth and strong from mechanical impulse.

15 In order to achieve this object, the LCD according to present invention includes a first substrate and a second substrate, two protective layers including at least one layer formed on outer surface of the first and second substrates, a transparent electrode formed on inner surface of the first substrate or the second substrate, an alignment layer formed on the transparent electrode, and two polarizers attached on the first and second substrates.

20 Each the protective layer material may be an inorganic matter having a compressive stress or an organic matter having a low viscosity coefficient, further the protective layer may be one layer including an inorganic layer or an organic layer, or a plurality  
25 of layers composed of same matter or different matter.

The inorganic layer is formed by a thin layer  
depositing method on the substrate, while the organic  
layer is formed by irradiating the light such as  
ultraviolet, visible ray, etc., onto a thermosetting  
resin deposited on the substrate and curing that.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIGS.1a, b are drawings showing a glass  
substrate having a protective layer in accordance with  
present invention, FIG.1a represents a protective layer  
on which bubbles appear, FIG.1b represents a protective  
layer on which cracks occur.

FIG.2 is a drawing showing a liquid crystal  
display device having the glass substrate of the  
FIG.1a, b.

#### DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to the  
present preferred embodiments of the invention,  
examples of which are illustrated in the accompanying  
drawings.

FIGS.1a, b are drawings showing a glass

substrate 1 having the protective layer, as shown in FIG.1a, a bubble, which is formed in process of manufacturing glass and its diameter is several  $\mu\text{m}$  - several ten  $\mu\text{m}$ , is appeared on the thin substrate which is etched less than 0.7mm. Further, since the thickness of the glass substrate 1 is very thin, a crack may be occurred by fine mechanical impulse as shown in FIG.1b.

A transparent protective layer 8 formed on the substrate 1 includes a plurality of layer having an inorganic matter or an organic matter, or an inorganic matter and an organic matter, then a refractive index of each layer is 1.4-1.6. the inorganic layer 8 is formed on the substrate 1 by general thin layer deposition method such as sputtering method, CVD(chemical vapor deposition) method, and evaporation method. While organic layer 8 is formed by irradiating the light such as ultraviolet, visible ray, etc., onto a thermosetting resin deposited on the substrate and curing that. At this time the inorganic matter having the compressive stress and the organic matter having the low viscosity coefficient(about several cp - several ten cp).

When bubbles appear on the surface of substrate 1 as shown in FIG.1a, an desirable image quality can not be achieved because of scattering of the light in a

bubble region.

Since the protective layer 8 is formed on the bubble as well as the surface of substrate 1, diameters of the bubbles are minimized from micrometer to angstrom. Accordingly when the substrate 1 is applied to a LCD, it is possible to prevent decreasing of an image quality by small scattering of the light in that region.

Additionally if cracks occur on the substrate 1 as shown in FIG.1b, the substrate 1 is broken down slowly according to passing of time in manufacturing process of the LCD. Further an impurity inserted in the crack cause to decrease quality of the LCD. While the inorganic layer prevent transmission of the crack by the compressive stress, and the cured organic layer also prevent transmission of the crack, thereby a strong glass substrate for mechanical impulse can be achieved.

The protective layer 8 may be one layer with an inorganic layer or an organic layer, or a plurality of layers composed of same matter or different matter.

FIG.2 is a drawing showing a liquid crystal display device having two glass substrates including the protective layers.

Each thickness of a first substrate 10a and a

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second substrate 10b is less than 0.7mm, a transparent electrode 12 made of such as ITO(indium tin oxide) is formed on the first substrate. In present embodiment, although, the transparent electrode 12 is formed on the first substrate, it is possible that the transparent electrode 12 is formed on the second substrate. Further alignment layers 13a, 13b including polyimide or photo alignment material are formed on the transparent electrode 12, then an alignment direction of the alignment layer is determined by using a mechanical or optical method. On the other hand a liquid crystal layer 15 is formed between the first and second substrates. The protective layer 18a, 18b are an inorganic layers or an organic layers, or a plurality of layers composed of same matter or different matter and formed on outside surface of both the first substrate 10a and the second substrate 10b. Continually a first polarizer 14a and a second polarizer 14b are formed on the protective layers 18a, 18b.

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Although not showing with drawing, TFTs(thin film transisters) are formed on the first substrate 10a, and a color filter layer is formed on the second substrate.

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After etching, grinding and scribing two glasses by general etching method, the protective



layers 18a, 18b are formed on that, and the transparent electrode 12 is formed on the protective layer 18a, 18b by the sputtering method. At this time, also it is possible to make the substrate 10a, 10b after the passivation layers 18a, 18b are formed on each the glass. Further the TFTs(not illustrated) are formed on the first substrate 10a by depositing and photoetching a metal layer, and the alignment layer 13a, 13b are formed by mechanical depositing or injecting the alignment material. Thereafter a plurality of spacers(not illustrated) are dispersed to maintain a gap between the first and second substrate 10a, 10b. After pouring the liquid crystal into a region between the first and second substrates and the two substrates are sealed, and thereby the LCD according to the present invention is completed.

In the above-discussed structure, since the protective layer includes an inorganic or an organic matter, the thin glass substrate through etching is bearable from a mechanical impulse.

Further in etching process, since the inorganic or organic matter have diameters of the bubbles which a quality of the LCD is down by that decreased, it is possible to achieve the good quality LCD having soft and uniform surface.

When cracks occur on the substrate, the protective layer prevent transmission of the crack thereby the substrate is not brokendown.

As a result, the present invention provides the good quality LCD having thin glass substrate light and its surface is smooth and strong from mechanical impulse.

Other embodiments of the invention will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims.